AMENDMENT TO THE CLAIMS

1. (Original) A sensor system for computing placement information about a component in an electronic component handling machine, the machine releasably holding the component and adapted to rotate the component, the sensor system comprising:

a sensor;

a plurality of light sources in the sensor disposed to illuminate a sensing field in the sensor;

a detector positioned relative to the light sources so that when the component is at least partially disposed in the sensing field, the component blocks illumination from at least one of the plurality of light sources to form a shadow of at least a portion of the component on the detector, the detector adapted to provide a plurality of detector outputs while the component rotates; and

computing electronics receiving the detector outputs to compute the placement information.

2. (Original) The sensor system of claim 1 further comprising energization electronics coupled to the plurality of light sources for energizing a one of the plurality of light sources substantially at a time.

3 (Original) The sensor system of claim 2 where the energization electronics energize the plurality of sources in a first pattern when the component has a first size and in a second pattern when the component has a second size.

4. (Original) The sensor system of claim 2 where the energization electronics energize the plurality of sources in a pattern which is independent of a size of the component.

5. (Original) The sensor system of claim 1 where the plurality of light sources are laser diodes.

6. (Original) The sensor system of claim 1 where the plurality of light sources are LEDs.

7. (Original) The sensor system of claim 1 where the plurality of light sources provide substantially incoherent light.

8. (Original) The sensor system of claim 1 where the plurality of light sources provide substantially coherent light.

9. (Original) The sensor system of claim 1 where the sensor is fixedly mounted on a head of the machine.

10. (Original) The sensor system of claim 1 where the sensor is not fixedly mounted on a head of the machine.

11. (Original) The sensor system of claim 1 where the energization electronics are in the sensor.

12. (Original) The sensor system of claim 1 where the energization electronics are disposed outside the sensor and within the machine.

13. (Original) The sensor system of claim 1 where the plurality of light sources are disposed to provide illumination in substantially the same plane.

14. (Original) The sensor system of claim 13 where the detector is disposed in the same plane as the plurality of light sources.

15. (Original) The sensor system of claim 1 where the machine rotates the component about a nozzle, the sensor system further comprising an encoder operably coupled to the nozzle to provide an encoder signal representative of angular orientation of the nozzle.

16. (Original) The sensor system of claim 1 where the detector comprises a plurality of detector portions.

17. (Original) The sensor system of claim 16 where the plurality of detector portions are each adjacent to the other portion.

18. (Original) The sensor system of claim 16 where the detector portions are coplanar with one another.

19. (Original) The sensor system of claim 16 where the detector portions are not coplanar with respect to one another.

20. (Original) The sensor system of claim 16 where each detector portion is disposed to image a different part of the component at a specific rotation, and each detector portion provides a data group based on the partial shadow, where the data groups when assembled by the computing electronics include a characteristic cusp, the characteristic cusp from a first data group occurring at a different orientation of the component than a characteristic cusp from a second data group.

21. (Original) The sensor system of claim 16 where each of the detector portions is disposed to have a principal axis oriented at an angle relative to another detector portion.

22. (Original) The sensor system of claim 21 where the angle is about ninety degrees.

23. (Original) The sensor system of claim 1 where the plurality of light sources comprises three light sources.

24. (Original) The sensor system of claim 1 further comprising a reflector disposed between at least one of the plurality of light sources and the detector.

25. (Original) The sensor of claim 1 further comprising a reflector disposed between the component and the detector.

26. (Original) A sensor system for computing placement information about a component in an electronics component handling machine, the machine releasably holding the component and adapted to rotate the component, the sensor system comprising:

a sensor;

a plurality of light sources coupled to an energization bus for energizing the light sources;

a detector positioned relative to the light sources so that when the component blocks the illumination the detector provides an output representative of a shadow of the component thereon, the detector providing a plurality of outputs as the component rotates;

energization electronics for providing the energization bus;

computing electronics coupled to the output of the detector for assembling the plurality of outputs to compute the placement information, where the energization bus energizes a one of the plurality

of light sources substantially at a time.

27. (Original) The sensor system of claim 26 further comprising a sensing field in the sensor illuminated by the plurality of light sources, the sensor operable when the component is partially disposed in the sensing field.

28. (Original) The sensor system of claim 26 where the energization electronics energize the plurality of sources in a first pattern when the component has a first size and in a second pattern when the component has a second size.

29. (Original) The sensor system of claim 26 where the energization electronics energize the plurality of sources in a pattern independent of a size of the component.

30. (Original) The sensor system of claim 26 where the plurality of light sources are laser diodes.

31. (Original) The sensor system of claim 26 where the plurality of light sources are LEDs.

32. (Original) The sensor system of claim 26 where the plurality of light sources provide substantially incoherent light.

33. (Original) The sensor system of claim 26 where the plurality of light sources provide substantially coherent light.

34. (Original) The sensor system of claim 26 where the sensor is fixedly mounted to move with the head of the machine.

35. (Original) The sensor system of claim 26 where the

sensor is not fixedly mounted to move with the head of the machine.

36. (Original) The sensor system of claim 26 where the energization electronics are in the sensor.

37. (Original) The sensor system of claim 26 where the energization electronics are disposed outside the sensor and within the machine.

38. (Original) The sensor system of claim 26 where the machine rotates the component about a nozzle, the sensor system further comprising an encoder operably coupled to the nozzle to provide an encoder signal representative of angular orientation of the nozzle.

39. (Original) The sensor system of claim 26 where the detector comprises a plurality of detector portions.

40. (Original) The sensor system of claim 39 where the plurality of detector portions are each adjacent to the other portion.

41. (Original) The sensor system of claim 39 where the detector portions are coplanar with one another.

42. (Original) The sensor system of claim 39 where the detector portions are not coplanar with respect to one another.

43. (Original) The sensor system of claim 39 where each detector portion is disposed to image a different part of the component at a specific rotation, and each detector portion provides a data group based on the partial shadow, where the data

groups when assembled by the computing electronics include a characteristic cusp, the characteristic cusp from a first data group occurring at a different orientation of the component than a characteristic cusp from a second data group.

44. (Original) The sensor system of claim 39 where each of the detector portions is disposed to have a principal axis oriented at an angle relative to another detector portion.

45. (Original) The sensor system of claim 44 where the angle is about ninety degrees.

46. (Original) The sensor system of claim 26 where the plurality of light sources comprises three light sources.

47. (Original) The sensor system of claim 26 further comprising a reflector disposed between at least one of the plurality of light sources and the detector.

48. (Original) The sensor system of claim 26 further comprising a reflector disposed between the component and the detector.

49. (Original) The sensor system of claim 26 where the machine is a pick and place machine.

50. (Original) The sensor system of claim 26 where the placement information includes an x,y and angular orientation of the component.

51. (Original) A sensor system for computing placement information about a component in an electronic component handling machine, the sensor system comprising:

a sensor releasably held by the machine, the machine adapted to rotate the sensor around the component;

a plurality of light sources in the sensor disposed to illuminate a sensing field in the sensor;

a detector positioned relative to the light sources so that when the component is at least partially disposed in the sensing field, the component blocks illumination from at least one of the plurality of light sources to form a shadow of at least a portion of the component on the detector, the detector adapted to provide a plurality of detector outputs while the component rotates; and

computing electronics receiving the detector outputs to compute the placement information.

52. (Cancel) A pick and place machine, comprising:

a transport mechanism adapted to receive and move a workpiece relative to machine;

a feeder adapted to feed a plurality of components;

a head adapted to releasably convey a component from the feeder to the workpiece;

a sensor for sensing placement information about the component, the sensor comprising;

a plurality of light sources adapted to selectively provide light onto a sensing field in the sensor;

control electronics coupled to the light sources to energize a one of the plurality of light sources substantially at a time; and

a detector disposed relative to the plurality of sources to receive at least one shadow portion of the component when the component is illuminated in the sensing field, the detector providing a plurality of detector outputs representative of

the shadow portion while the component rotates; and

an encoder coupled to the head to provide data representative of an angular orientation of the component; and

processing electronics coupled to the encoder and the sensor, the processing electronics operating on the plurality of detector outputs and the encoder data to provide placement information about the component.

53. (Original) A method for computing placement information about a component, method comprising:

1) picking up the component;

2) transporting the component to a sensing field within a sensor, the component partially within the sensing field;

3) energizing a first light source within the sensor, the first light source illuminating a portion of the component from a first angle so as to form a shadow on a detector;

4) capturing the shadow and providing a detector output at a first angular orientation of the component;

5) energizing a second light source within the sensor, the second light source illuminating a portion of the component from a second angle so as to form a shadow on the detector;

6) capturing the shadow and providing a detector output at a second angular orientation of the component;

7) repeating the steps 3) through 6) for a plurality of angular orientations of the component; and

8) processing the detector outputs and the angular orientations associated therewith to compute an orientation of the component.

54. (Original) The method of claim 53 where the orientation includes an x, y and angular position of the component relative to a machine coordinate system.